APOLLO APLICATIONS PROGRAM

as of Jan 23 '66

PROGRAM DIRECTIVE NO. 4

INTERIM AAP CRITERIA

FOR

DEFINITION, DEVELOPMENT & TEST

OF

AAP HARDWARE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D. C. 20546

OFFICE OF MANNED SPACE FLIGHT PROGRAM DIRECTIVE	M-D ___ (Project)	DATE

JAN 23, 1967

APOLLO APPLICATIONS
PROGRAM DIRECTIVE NO. ___

TO : Distribution

FROM: DIRECTOR, SAA PROGRAM

SUBJECT: Interim AAP Program Criteria for Definition, Development and Test of AAP Hardware

I. PURPOSE:

A. This Directive establishes interim criteria to be used by the center Apollo Applications Program Offices in definition, development and test of AAP hardware.

B. This Directive and the formal program documents (see para. II.A) are designed to ensure that:

1. development and test costs are held to a minimum consistent with crew safety and the accomplishment of primary program and flight mission objectives;

2. standard minimum requirements are imposed on definition and development contracts.

II. SCOPE AND APPLICABILITY:

A. This Directive applies to experiment hardware, new hardware and modified Apollo hardware developed for the Apollo Applications Program. It is applicable to AAP Offices at Headquarters, centers and other center organizations whose activities are directly supporting AAP. It will be replaced by the following documents as soon as they are issued.

1. Experiment General Specification. To be issued by MSF to be placed on contracts by MSF centers as a standard for the preparation of Contract End Item (CEI) Specifications for experiment hardware definition and development test.

2. Apollo Applications Test Requirements Document (AATR). To be issued by the SAA Program Director to establish minimum requirements for development/testing of AAP hardware.

B. The criteria established in this Directive shall be applied to the following definition and development phases:

1. For Experiment Hardware:

a. Definition Requirements for MSFEB Approval. The technical part of the Experiment Implementation Plan (EIP) shall be identifiable as Preliminary Part I Contract End Item (CEI) Specification. It shall be sufficient for mission compatibility review. The EIP (technical, schedule/resource and management) shall be the basis for official assignment of experiment to Apollo Applications Program Office for hardware development.

b. Development Requirements after MSFEB Approval. The Contract End Item (CEI) Specification (Parts I and II) shall be the basis for experiment hardware design, development, fabrication, testing and operation.

Attachment I contains sample end products for experiment hardware which results from applying the requirements defined above.

2. For New Hardware and Modified Hardware:

a. Definition Requirements as Design Baseline. Each end item shall be identified by a Part I CEI Specification which defines the performance, preliminary design, development and test of the new or modified hardware appropriate to the definition phase.

b. Development Requirements as Hardware Baseline. Each end item shall be identified by a Part II CEI Specification which defines the final design (mostly drawings), fabrication methods, testing requirements, quality provisions, delivery provisions, and operation of flight configured hardware appropriate to the development/operation phase.

III. PHILOSOPHY AND CRITERIA:

The AAP is to be conducted with maximum consideration of performance, cost and schedule effectiveness. It is therefore essential that systems or elements of systems shall be defined by systems engineering analysis which translates objectives of a system or its elements into contract end item requirements (specification covering performance, design and test requirements) by:

- defining functions and their relationships (or flow diagrams)
- synthesizing alternate approaches
- optimizing trade-off studies in terms of properly weighted performance/cost/schedule effectiveness for major decisions
- identifying the selected approach in terms of equipment, facilities, personnel and data as required
- identifying testings to verify hardware performance

In this activity the following major criteria shall be used in identifying performance, design, test and documentation requirements:

A. Criteria Applicable in Defining Performance, Design and Test Requirements:

1. Use existing resources. Maximum use shall be made of available resources, (e.g., Apollo, Gemini/other Government facilities, equipments, procedures, data and personnel).

2. Apply AAP hardware criticality categories. Performance, design and testing requirements shall be established in accordance with AAP hardware criticality categories:

CAT 1 - Hardware, the failure of which could affect crew safety.

CAT 2 - Hardware, the failure of which would result in not meeting the primary objective of the mission.

CAT 3 - Hardware which does not fall into the above two categories.

Experiment and AAP peculiar hardware criticality categories shall be identified by cognizant SAA Program Manager, consistent with the AAP mission directives. The performance, design and test specification or requirements established should be most stringent for CAT 1 and 2 hardware and less stringent for CAT 3 hardware. (It should be recognized that hardware, the failure of which results in failure to achieve a secondary mission objective, is categorized as CAT 3.) Experiments which are flown as secondary mission objectives, or CAT 3 hardware, should have the following minimum requirements:

- Failure and defect reporting; analysis and control
- Appropriate testing as identified in paragraph III.B.2

3. Prepare a specification for each end item or each system which contains many end items of hardware.

a. Each specification shall contain the following two major sections:

(1) Performance and design requirements (including interface requirements)

(2) Test requirements/quality assurance (against (1) above).

b. The program, project and CEI specifications shall be in accordance, as applicable, with Exhibits I through VI of NPC 500-1 on an added, deleted and modified basis and constrained by the requirements specified herein. Simplified formats as described in Exhibits III and IV shall be used where practical. The relationships of the program/project specifications, Experiment General Specification, Experiment or Carrier CEI Specification, and Interface Control Document (ICD) are depicted in Attachment 2. A description of a typical ICD requirement is shown in Attachment 3. (Configuration management shall be defined under separate AAP document.)

4. Maximize equipment standardization. Common equipment shall be designed for multiple use where practical. Qualified Apollo and other space program parts, assemblies or subsystems shall be used. Modular add-on shall be designed to the maximum extent possible, consistent with trade-off studies. Mission and/or program optimization shall be considered by grouping related experiments or new hardware into a single item of hardware whenever possible.

5. Simplify hardware interfaces. Experiment hardware shall be designed to minimize physical and functional interfaces with the carrier hardware, consistent with the results of trade-off studies.

6. Minimize crew time. Hardware shall be designed to minimize crew training and crew time requirements, consistent with crew safety and achieving mission primary objectives.

7. Select the proper factors of safety. Such factors shall be specified for all hardware in the Part I CEI Specification, within the constraints of performance and weight. The conservative applications of safety factors, derating factors and design margins will permit design verification by analysis techniques, and will contribute to reducing the cost of testing and quality assurance.

8. Select materials in crew quarters to insure crew safety (including S-IVB Orbital Workshop, Airlock Module, Command Module, Lunar Module, Multiple Docking Adapter) and associated experiments should be selected in accordance with:

   a. Procedures and Requirements for the Evaluation of Apollo Crew Bay Materials, MSC-A-D-66-3.

   b. Crew Bay Non-metallic Materials Status Report, MSC-A-D-66-4.

9. Identify minimum requirements from NASA documents, (e.g., NPC 250-1, NPC 200-2). It is undesirable to specify an entire document on contract unless the entire document is applicable. Only the applicable paragraph or its modification shall be specified.

10. Incorporate incentive contract provisions. Incentive provisions shall be incorporated to effect savings in design, testing and associated data requirements. Clear criteria in terms of properly weighted performance, cost and schedule shall be established for evaluation.

11. Establish maintainability criteria for design of new Categories 1 and 2 flight hardware. Analyze existing Categories 1 and 2 hardware for design changes to obtain in-flight maintenance capability. Establish design requirement of replaceable packaged subsystems for new Categories 1 and 2 hardware.

12. Review to maintain realistic requirements. Continuous reviews shall be conducted to: (a) update performance and test requirements and equipment schedules as a result of knowledge gained from earlier activities or flights, and (b) reduce unrealistic requirements. Minimum formal reviews (PDR's, CDR's, COFW's, FACI's, DCR's, and FRR's) are established in Apollo Program Directives 6A, 7 and 8, as modified for AAP.

B. Criteria Applicable in Defining Test Requirements.

1. Establish test program management which contains elements of identification, status and performance review/control. These elements are:

ELEMENTS	ITEMS	DOCUMENTS
IDENTIFICATION	• Test required • Test constraints • Test conditions • Test hardware • Test facilities • Test schedules • Test results, etc.	• AAP Test Requirements Document (AATR) • Specifications (test requirements) • Test plans • Test procedures • Test reports • Mission directives, etc.
STATUS	• Control milestones • Procedure and document preparation status • Development test status • Certification or qualification program status • Failure status, etc.	• SARP/PERT charts • Status reports • Failure reports • Test schedules, etc.
PERFORMANCE REVIEW/CONTROL	• Certification of meeting specs., plans and schedules • Corrective actions (redesign, spec., schedule and/or testing change)	• Meeting minutes and/or reports on PDR's CDR's, FACI's, COFW's, DCR's, FRR's and other test reviews • Corrective action reports • Program review minutes, etc.

2. Consider AAP test program as one integrated test program. The AAP consists of many flight missions. Each flight mission involves hardware that will require development tests, qualification tests, acceptance tests, payload (integrated systems) tests, prelaunch tests, flight verification tests and post-flight tests. This spectrum of tests shall be analyzed as an integrated effort to minimize test duplication.

3. Where practical, conduct testing at highest hardware generation level with minimum piece part testing.

4. Conduct complete acceptance testing at the origin, (e.g., complete experiment hardware acceptance in accordance with cognizant test specification at the experiment manufacturing site to reduce duplicate testing and required resources at the payload integration site. Acceptance tests should include environmental testings of sufficent severity to uncover the latent defects but not severe enough to cause any significant damage to the component. Payload integrator should not repeat testings of experiment hardware which should have been completed by experiment developer prior to delivery. This does not preclude functional test and inspection prior to installation of experiments into the carrier.)

   Exception: Where mod kit or experiment hardware to be installed at launch site, acceptance testing of the integrated systems (mod kits, experiments and carrier) shall be conducted at KSC.

5. Effect combined testing with other programs, (e.g., for Apollo/ Apollo Applications hardware, test only the delta between the two requirements and utilize Apollo hardware and facilities to effect savings).

6. Avoid requalification of experiment or AAP peculiar hardware (e.g., qualified Apollo hardware will not be requalified for AAP if both requirements are the same or comparable).

7. Accomplish where practical qualification and delta qualification by analysis and supplement tests only if analysis predicted on other program qualification tests is not considered adequate as full qualification.

8. Prepare the test specification against the performance/design requirement for each item of hardware. The test requirement or specification, which is part of the CEI Specification (paragraph III.A.3), shall be prepared in terms of the type of test (development, qualification, integrated systems, etc.) to demonstrate that performance/design requirements are to be met. NPC 500-10 and PDP should be used as a baseline for identifying test requirements. Verification matrices of test requirements against each performance/design requirement should be included in the CEI Specification.

9. Consider recertified ground test hardware as flight or backup hardware. Experiment hardware which has been subjected to environmental qualification tests may be utilized as flight or backup hardware provided that:

a. Crew safety is not compromised, and

b. The hardware is recertified to meet CEI performance and test specification by refurbishing those components whose performance may have been degraded by the environmental testing.

10. Conduct material compatibility testing if no known reference source or previous test which certifies that the material selected is compatible over the specification range of both fluids and other interfacing materials under expected use conditions (e.g., manufacturing, testing, flight and post-flight analysis).

11. Implement and test feed back system. An effective system should be established and implemented to insure that ground and flight test results are analyzed and fed back into the design and test planning for action.

C. Documentation:

Minimize documentation. Minimum documentation and data requirements consistent with absolute need and cost effectiveness shall be specified. This is especially for hardware which falls in CAT 3. Contractor delivered documents should be emphasized on end product oriented data rather than in-process development data. All documentation shall be identified in a document requirement list (DRL, NASA Form 1106), and document requirement description (DRD, NASA Form 1107), to be approved by the cognizant center. The Apollo Documentation Administration Instructions, NPC 500-6, may be used as a guide for identifying, selecting, acquiring, controlling and scheduling of minimum essential documents. Administrative policy on requirements and responsibility for experiment data storage and distribution shall be determined by NASA Headquarters. NPD 8030.3 (dated January 7, 1967) specified policy concerning data obtained from space science flight experiments. The contractor internal working paper shall be employed as program working paper where practical. The DRL should identify the following categories of documents:

I - Documents submitted to NASA for approval and retention
II - Documents submitted to NASA when requested.

IV. REFERENCE DOCUMENTS:

Until formal AAP requirements documents are issued, the reference documents listed in Attachment 4 may be used as a guide to satisfy the requirements specified in this Directive.

V. IMPLEMENTATION/DEVIATIONS:

A. This Directive is effective immediately.

B. Deviations and waivers may be requested for the requirements cited herein whenever such deviation results in increasing system or element of system performance, cost, and schedule effectiveness. To this end, requirements in new contract work statements should be periodically assessed to effect desirable deviations and waivers.

C. The center shall submit deviations and waivers with justifications on existing and new contract work statements to the Saturn/Apollo Applications Program Director for review.

AAP SPECIFICATION MATRIX

	Prepared By	Concurred By	Issued By	Purpose
1. AAP Experiment General Specification	MSC MSFC to provide support	OMSF, OSSA, OART, and appropriate Centers	SAA Program Office	Specify over-all performance, design & test requirements for all experiments. Impose carrier interface requirements on all experiment contractors and principal investigators. Identify over-all documentation reqm'ts.
2. AAP Program Specification	SAA Program Office		SAA Program Office	Identify AAP Program over-all system (including experiments) performance and test requirements for all missions. Reference APP Experiment General Spec.
3. Center Project Specification(s)	Center SAA Program Office	Other related Center SAA Program Office(s) (OMSF, OSSA, OART as req'd)	Center SAA Program Office	Identify cognizant center level system (including experiments) performance/ design/test reqm'ts for all missions. Reference AAP Experiment General Spec. Identify spec trees.
4. Experiment CEI Spec. Design/Performance Requirements	Experiment Dev. Contractor	Principal Investigator	Experiment Development Center	Specify performance, design, and test requirements for each experiment contract end item (based on AAP Experiment General Specification, the ICD, and experiment definition proposal).
Test Requirements	Experiment Dev. Contractor	Payload Integ Center & Contractor* P.I.		
5. AAP Carrier or other CEI Specifications	Assigned Center	Related Center	Assigned Center	Identify performance, design and test requirements for the Carrier or contract end item.
6. Interface Control Document (ICD)	Payload Integ. Center and/or	Experiment Dev. Center & Con-	Payload Integ. Center	Provide an official agreement which shows detailed physical, functional

EXPERIMENT END PRODUCTS BY PROGRAM PHASES

PHASE / ITEMS	DEFINITION PHASE REQUIREMENTS TO DEFINE THE EXPERIMENT SUFFICIENTLY FOR SAA MISSION COMPATIBILITY REVIEW	APPROVAL OR DISAPPROVAL	DESIGN/DEVELOPMENT/OPERATION PHASE REQUIREMENTS FOR DESIGN, FABRICATION, TESTING, QUALITY CONTROL, CHECKOUT, PREPARATION FOR DELIVERY AND OPERATION OF EACH FLIGHT CONFIGURED EXPERIMENT HARDWARE.	
			AAP	
PRIME RESPONSIBILITY	OSSA, OMSF OR OART;MT	MSFEB	DESIGN BASELINE	HARDWARE BASELINE
PRIME END PRODUCTS	EXPERIMENT PROPOSAL (FORM 1138) EXPERIMENT IMPLEMENTATION PLAN (EIP)* (TECHNICAL, SCHEDULE/RESOURCE AND MANAGEMENT) BREAD BOARDING	MSFEB MINUTES	NASA SPECS CEI SPEC (PART I) BREAD BOARDING UPDATED PREL. DRAWINGS PRELIM. TEST PLANS OTHER PROGRAM PLANS	WORK STATEMENT CEI SPEC (PART II) FORMAL DRAWINGS INTERFACE SPECS., OR ICD'S TEST PLANS/DATA HARDWARE/SOFTWARE DD 250'S OPERATION PLANS OTHER PROGRAM PLANS

Mission Compatibility Report Submit for Approval

Go ahead for Hardware Design

Go ahead for Hardware Dev. Contract

Delivery of Hardware

* Technical requirement is the preliminary Part I CEI Spec which contains performance requirements, preliminary drawings, interface requirements and test constraints/approach for a mission.

e ICD's shall be prepared by the payload integration centers and be coordinated by e cognizant experiment development centers, space vehicle development centers and propriate contractors.

D's will be prepared as soon after experiment contract initiation as practical and ll cover all interface and schedule requirements needed to satisfy integration of periment equipments into the space vehicle. To expedite experiment definition, eliminary definition of the interface requirements, AAP Experiment General Specifition, and/or other carrier design envelopes for experiment equipment shall be proded to the experiment developer, as soon as these are available.

e minimum experiment interface requirements to be included in the ICD are listed low. Any deviation from these configuration and interface constraints in the periment proposal shall be submitted in form of an ICD for acceptance. Typical terface data are:

Space Vehicle

a. Physical

(1) Weight where possible shall be specified for each experiment hardware and its elements. Weights should be no greater than that specified in the experiment proposal.

(2) Volume and shape should generally conform to that proposed in the experiment proposal.

(3) Wiring and plumbing sizes and locations shall be identified and dimensioned.

b. Functional

(1) Power required by the experiment should conform to the power availability and characteristics established by the appropriate space vehicle performance specification.

(2) Attitude control should be designed to operate within the space vehicle control constraints established by the appropriate space vehicle performance specification.

(3) Cooling plates/environmental control and their allocations shall be established by appropriate space vehicle performance specification.

(4) Display and control design will be designated in accordance with requirements established by appropriate space vehicle performance specification.

(5) Data collection instrumentation design shall be compatible with the space vehicle recording and telemetry capability and their allocations established by space vehicle performance specifications.

(6) Crew participation and man-machine interface requirements shall be identified.

Ground Support Equipment. Experiment and its support equipment shall be designed to be compatible with existing GSE and space vehicle checkout systems established by GSE performance specification or equivalent.

REFERENCE DOCUMENTS

Until formal AAP requirements documents are issued, the following listed documents may be used as source documents to satisfy the requirements specified in this Directive.

	Title	Document No.
1.	AAP Program Development Plan	(Draft)
2.	AAP Program Specification	(In Development)
3.	AAP Test Requirements Document	(In Development)
4.	Apollo Configuration Management	NPC 500-1
5.	Experimenter Design Guide (Design envelope info on CSM/LM Lab for alternate missions, applicable up to and including preliminary design)	(SID 65-1536 & GAEC Design 3788 to be consolidated and refined as an AAP document)
6.	Apollo Program Specification	SE 005-001-1
7.	Quality Assurance Provisions for Government Agencies	NPC 200-1A
8.	Quality Program Provisions for Space System Contractors	NPC 200-2
9.	Inspection System Provisions for Supplier of Space Materials, Parts, Components and Services	NPC 200-3
10.	Quality Requirements for Hand Soldering of Electrical Connections	NPC 200-4A
11.	Reliability Program Provisions for Space Systems Contractors	NPC 250-1
12.	System Engineering Management Procedures (guide only)	AFSCM 375-5
13.	Natural Environment and Physical Standards for Apollo Program	MDE 8020-008B
14.	Apollo Documentation Administration Instruction	NPC 500-6
15.	Design and Qualification Test Requirements for Apollo Experiments, Pallet Experiments Hardware (guide only)	(Interim, MSC Draft)
16.	Orbital Workshop Manned Spacecraft Center Experiments Requirements	NASA General Working Paper No. 10,065
17.	Saturn/Apollo Applications Program Technical Summary (for planning purposes only, OMSF, September 1, 1966)	(No number)
18.	AAP Experiment Implementation Plan (Draft, SAA Program Office)	(No number)
19.	Payload Development Documents (Draft, Lockheed and Martin for MSFC)	(No number)
20.	Final Reports on Payload Integration Studies (MSFC)	(In Development)
21.	AAP Reliability and Quality Assurance Program Plan	(Draft)